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THE DISCRIMINATION OF ARTICULATE SOUNDS BY RACCOONS.

By W. T. SHEPHERD, Ph.D.

The present paper in some respects may be considered as a supplementary report to one on the same subject made by Professor L. W. Cole, and published by him about three years ago.¹ In the work reported by Professor Cole, in which I assisted, four raccoons were used and in this later work, now to be presented, the same animals were employed. The results which are given here have not previously been published, and only in a minor degree can they be considered merely supplementary to the work of Cole. The experiments to be reported are concerned with the Discrimination of Articulate Sounds by Raccoons.

It is commonly believed, and with some degree of reason, that the higher mammals can be taught to respond to their names, or to express it more accurately, to discriminate articulate sounds and to make appropriate motor responses thereto. It is well known that cats, dogs, horses and other domesticated animals learn to respond to their given names; but it is not known, from well conducted experiments, whether there is in these cases a discrimination of quality, of loudness, or of time of the sound. The results that have been obtained with animals under experimental conditions have been few, and in some cases the differentiation of tone, and intensity has not been made. Thorndike, it will be remembered, found that cats were apparently able to discriminate sounds made by him, though not with a great degree of delicacy.² The sounds that Thorndike used were quite complex in character, such as, "I must feed those cats" and "My name is Thorndike." In his work on the functions of the temporal lobes Kalisher reported³ having been able to get dogs to discriminate sounds made by an harmonium, but he was more interested in producing the association for the purpose of determining (after extirpation of different parts of the

¹Concerning the Intelligence of Raccoons, Jour. Comp. Neur. And Psych. Vol. 17, p. 211.

²Animal Intelligence, 1898.

³Eine neue Hörprüfungsmethode bei Hunden, Sitz. d. Kgl. Ak. d. Wiss., X, 1907. p. 204 ff.

cerebral cortex) the cortical centres for sound perception than ability in his animals to discriminate sounds.

At the time the experiments were begun the raccoons were about six months old, and they had been trained for two months on various motor acts, reported in Cole's paper. In the early training period we had spoken to the animals, using different names, but the naming and calling was not done regularly and systematically. During the course of these preliminary experiments some of the animals had given indications of associating the sounds with reactions, and one in particular reacted often. Since no record of these experiments was made we cannot say how often the stimuli were given, and how well or poorly each animal reacted. For a period of two months following these trials no experiments on sound discrimination were made. Then the present work was begun.

For these tests each raccoon was placed in a separate cage which had a wire netting front. The four cages were arranged in different parts of the room and I sat at a distance of from four to eight feet from the cages. The names of the raccoons were called in irregular order, and I noted whether each responded only to the sound of his own name or to all the names. Each animal was fed when he responded to his own name (and was not fed when the other names were called). The animals were named, Jack, Jim, Tom, and Dolly. During these experiments all were kept very hungry.

1st day: In 168 experiments (42 trials for each animal) in which the reaction of turning and looking at me was taken as response, Jack reacted correctly 6 times, 3 doubtfully correct; Jim, 11 correct, 3 doubtful; Tom, 9 correct, 5, doubtful; Dolly, 1 correct, 2 doubtful. All the animals responded to the first call, but it is likely that was only an attention reaction; *i. e.*, a movement following a stimulus given by one familiar to the animals.

2nd day: After the preliminary trials of the first day I no longer fed the animals for this simple reaction. Responses were only noted correct when they climbed up the side of the cage, in addition to looking at me. Each raccoon was fed after his name was called, whether or not he gave the proper reaction. In 188 experiments (47 for each animal) Jack reacted correctly 21 times; Jim, 9; Tom, only 2 doubtful; Dolly, 1 correct with 4 doubtful. The results of these two days' experiments indicated that Jack and Jim could easily learn to respond to their names.

3rd day: Throughout the remainder of the experiments each animal was tested separately and the other three were kept out of his sight. I called the name of the animal, waited

10 seconds, if need be, for response, and then, whether or not a response was obtained, the animal was fed. Alternately with the name, the words "no feed" were called, and at these times the animal was not fed. In each case, as noted above, the correct reaction was considered to be obtained only when the raccoon looked at me and climbed up the side of the cage. In 50 trials on each kind of auditory stimulus Jack correctly reacted to his name 39 times and to "no feed" 22; in 30 similar trials Jim correctly reacted to his name 21 times and to "no feed" 15; Tom in 30 trials correctly reacted to his name 16 times, to "no feed" 10, with 13 doubtful in all; Dolly in 30 trials correctly responded to her name 15, to "no feed" 5, with 1 doubtful.

The experiments were continued in this way for 18 days, at the end of which time all the animals appeared to know their names perfectly. Thirteen days after the beginning of the experiments Jack correctly reacted to his name every time (25 trials), and incorrectly to the "no feed" signal only 3 times (25 trials). About the same percentages of correct and incorrect responses were obtained for Jack during the 8 succeeding days of the experiment. It appeared to me that Jack's few errors from this point might be accounted for by his eagerness for food.

After the names appeared to be well learned, as further test of auditory discrimination, I called other names, in addition to the individual's name, such as "box," "floor," after each name: *i. e.*, I called Jack, "box," "floor" in succession, and not alternately. No substantial difference in the percentage of proper responses was noted. It seems evident, therefore, that the animals had formed the habit of responding only when the appropriate sound was heard, and of not responding to other sounds. To further test the animals, I called the names and sounds in varying tones of voice, the lowest to the highest possible to me, and also had other persons call the words and names. With all the animals the responses were strikingly characteristic of discrimination.

May we, therefore, conclude that raccoons discriminate names or articulate sounds? The answer to this question will depend to a large extent upon the acceptance of the later experiments as conclusive. A serious objection to such a conclusion may be urged by some. It may well be said that, in the major part of the experiments, where the name and "no feed" were called alternately, the raccoons had learned to react alternately and that they reacted only to the rhythm of the stimuli. On the other hand, it must be remembered that following those experiments of alternate calls, there was a series in which the names were not called in any regular

order, and there was the same percentage of correct responses. Moreover, the addition of extra sounds to the names did not alter the proportional number of responses. Both of these later tests permit us to conclude, therefore, that the discrimination did take place.

It is of some interest to note that, Jack, which judging from the results of the earlier tests and from others to be reported in a later paper, was the most intelligent animal of the four, learned to associate the name with the proper response in 270¹ trials, Tom took 375 trials, Jim 425, while 500 trials were required for Dolly. This individual difference in animals experimented upon has been a noticeable feature in other experimenters' work, but to the mind of the writer not sufficient attention has been paid to it, and therefore animal psychologists have been content to work with a small number of animals (four, two, or even one) and to draw from their results too broad conclusions.

¹That is to say I called Jack's name 270 times and the other words "no feed," etc., in addition.